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Problem Solving Ability in the Learning Model of Problem-Based Learning based on Ethnomathematics

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Abstract

This study has the purpose of analyzing the effectiveness of the Problem-Based Learning model based on ethnomathematics with Selotigo batik motifs in improving students' problem-solving abilities. This study was true experimental design research. The sampling technique was done using random cluster sampling. The sample in this study was Public Elementary School Sidorejo Lor 07 Salatiga as an experimental class and Public Elementary School Sidorejo Lor 03 Salatiga as a control class with a total of 74 students. The data collection was done through observation, documentation, and test method. The data analysis was done using One-Sample t-test, Proportion Test, and Independent Sample t-test. The results showed that the PBL model based on ethnomathematics was effective in improving students' problem-solving abilities. This result was indicated by the average score of students' problem-solving ability in the learning using PBL model based on ethnomathematics which was above the Minimum Completeness Criteria (KKM) with KKM of problem-solving abilities of 75, the proportion of students completeness of problem-solving abilities in PBL model based on ethnomathematics was above 75% of the classical completeness, the average problem-solving ability of students in the PBL learning model based on ethnomathematics is better than the average problem-solving ability of students in the PBL model. Based on the result, it can be concluded that problem-solving in a PBL model based on ethnomathematics is effective in improving the problem-solving ability of students.

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INTRODUCTION

Problem-solving ability is a basic skill that must be possessed by a student in living life to survive and develop themselves when dealing with a problem. Based on Permendikbud Number 21 of 2016 concerning standard content of primary and secondary education, one of the competencies that will be achieved in the process of learning mathematics is the ability to solve problems. This is in line with Nyala (2016) who stated that the fact could not be denied for problem-solving is one of the standard processes that quickly becomes the key in learning mathematics. Problem-solving is a basic component for learning and also for the acquisition of knowledge (Ayllon, 2016). Meanwhile, Santoso (2013) stated that the ability to solve problems is a basic skill that must be possessed by someone to lead a better life.

Education is expected to help students have good problem-solving skills to be able to solve problems and questions related to subjects in particular mathematics in school. Mathematical problems are given to students at school with a purpose to train the student's intellectual abilities in understanding, planning, doing, and obtaining solutions for every problem.

According to the observations and interviews with the classroom teacher regarding the problem solving of mathematics in grade 4 at Public Elementary School Sidorejo Lor 07 Salatiga, it was obtained results that the daily mathematics test shows that the students' problem-solving abilities of students were still low. Based on the results, it was found that some students still have difficulty in interpreting the problems, so that they found difficulty in conducting the steps of problem-solving and the final results that were not good innovate. This indicated that the problem-solving ability of students of grade 4 at Public Elementary School Sidorejo Lor 07 in Salatiga is still low.

The learning at Public Elementary School Sidorejo Lor 07 Salatiga has applied the 2013 curriculum where the learning process is carried out with an integrated thematic learning approach, except for the mathematics subjects which is an independent subject for grade IV, V, and VI (Permendikbud, 2016). However, the learning in the classroom has not fully applied the principles of the integrated thematic approach, and the learning is still teacher-centered in which the learning is more dominant using conventional methods or using the lecture method.

Efforts are made to find solutions by developing learning that uses models, strategies, and methods, and techniques that can improve students' mathematical problem-solving abilities. In this case, it will develop a learning tool that can facilitate the formation of problem-solving abilities. The factors that influence the ability to solve mathematical problems (Pimta, 2009) are; direct and indirect, direct factors are attitudes toward mathematics, self-esteem, and teacher teaching behavior. Meanwhile, indirect factors are motivation and self-efficacy.

From the above problems, it can be assumed that the Problem-Based Learning (PBL) model is one of the good learning models for improving learning outcomes in problem solving ability. This is in line with the results of research by Hendriana (2018), who stated that the PBL model is better than the conventional learning viewed from the ability to solve the mathematical problems. Siriwat & Katwibun (2017) stated that the Problem-Based Learning (PBL) model is an educational approach where learning is driven from problems in the real world. Meanwhile, according to Widyatiningtyas (2015) Problem-Based Learning (PBL) model is a challenging learning approach for students to learn problem-solving done in groups.

It is expected that through the Problem-Based Learning (PBL) model, students can analyze themselves and criticize a given problem so that later students can solve various problems encountered. The Problem-Based Learning (PBL) model is expected to be able to encourage students to understand the many problems, then think about how students can carry out authentic investigations and also investigations that require real solutions to real problems. Besides being able to enhance students to think creatively, learning using Problem-Based Learning (PBL) models focuses on the problem-solving process.

Currently, students learn mathematics with problems that are not suitable in their daily lives, so that they find it difficult to solve problems in mathematics. So that mathematics learning becomes easier to understand and meaningful, learning can use the problems that exist in the environment around students, especially the local culture that is in the place of residence. The students will not get bored in following the learning mathematics process.

A culture that is directly related to mathematical concepts is usually called ethnomathematics, in which cultural elements in the student's residence can be used as a source of learning with the hope that learning takes place more meaningfully. In line with Abdullah, Mastur, and Sutarto (2015) states that the application of ethnomathematics as a means of motivating and stimulating students can overcome boredom and learning difficulties which in turn can improve the learning outcome of students in mathematics. Rosa & Orey (2011) found that the application of ethnomathematics to the curriculum in schools helped in developing students' intellectual, social, emotional, and political learning by using their unique cultural references in imparting knowledge, skills, and attitudes. According to Geni, Hidayah, & Zaenuri (2017) stated that ethnomathematics is mathematics applied by certain cultural groups, groups of workers and professionals, children from certain class communities, indigenous tribes, and others.

Ethnomathematics is the study of mathematical techniques used and can be identified through cultural groups in understanding, explaining, and managing problems and activities that arise within themselves (Yusuf, 2010). Through the application of ethnomathematics in learning, students are expected to better understand mathematics while understanding their culture, and later it will be easier to instill cultural values in students' daily lives. The widespread use of mathematical concepts in ethnomathematics related to various mathematical activities, including grouping, counting, measuring, designing buildings or playing equipment, determining locations, and other things. So with ethnomathematics based learning students can learn mathematics and get to know the culture.

Based on the above background that has been described, the formulation of the problems examined in this study was whether the average score of students' problem-solving abilities in the learning using Problem-Based Learning (PBL) models based on ethnomathematics above the Minimum Completeness Criteria (KKM) with KKM problem-solving abilities of 75, whether the proportion of completeness of students' problem solving abilities with Problem-Based Learning (PBL) models based on ethnomathematics above the classical completeness of 75%, whether the average ability of students' problem-solving in Problem Based Learning (PBL) learning models based on ethnomathematics is better than the average of students problem-solving ability in Problem-Based Learning (PBL) model.

The purpose of this study was to determine whether: the average score of students' problem solving abilities in learning using Problem-Based Learning (PBL) model based on ethnomathematics nuances above the Minimum Completeness Criteria (KKM) with KKM problem solving abilities of 75, the proportion of completeness of problem solving abilities of students in Problem-Based Learning (PBL) model based on ethnomathematics above the classical completeness of 75%. The average problem-solving ability of students in Problem-Based Learning (PBL) learning model based on ethnomathematics is better than the average of students' problem-solving ability in the PBL model.

METHODS

This study was experimental research, and the design applied in this study was true experimental design. The design was used by Post-test Control Group Design. In the Post-test Control Group Design, there are two groups, and each group is randomly chosen (R) presented in Table 1.

Table 1. Research Design

Pre-test data	Grade	Treatment	Test
UAS score of the first semester	Experiment	The learning using PBL model based on ethnomathematics	Test of problem-solving ability
UAS score of the first semester	Control	The learning using PBL model without ethnomathematics	Test of problem-solving ability

Population in this study was grade 4 students of the Imam Bonjol group in Salatiga in the first semester of academic year 2018/2019. The sampling technique was used cluster random sampling technique. After completing the collection, Public Elementary School Sidorejo Lor 07 was selected as an experimental class given a Problem-Based Learning (PBL) learning model based on ethnomathematics and Public Elementary School Sidorejo Lor 03 as a control class given a Problem-Based Learning (PBL) learning model without ethnomathematics.

The data collection method in this study was carried out using the method of documentation, observation, and tests. The documentation method was used to obtain the pre-test data on the students of the research sample. Meanwhile, the test method was used to obtain data on students' problem-solving abilities on the circumferential material and flat area using test questions in the form of essay that has been tested previously. The score of students' problem-solving abilities in the circumferential material and wide of the flat area was then processed to test the research hypothesis. The observation method was used to observe student activities during the learning process.

Based on the results of the analysis of the instrument trials on problem-solving ability tests that include validity, reliability, level of difficulty, as well as the different power of the questions obtained items that are feasible to be used as test questions on the evaluations in measuring the students' problem-solving abilities.

The data analysis techniques applied in this study were normality test using Kolmogorov-Smirnov test, homogeneity test using statistical Levene test, one-sample t-test, one-sample proportion test, and independent-sample t-test.

RESULTS AND DISCUSSION

Based on the results of the analysis at pre-test through the Kolmogorov-Smirnov test with a 5% significance level using SPSS 22, it was found that the significance value of 0.191 > 0.05 indicates that the samples in the study were normally distributed and through the data of homogeneity test in the output table Test of Homogeneity of Variance with a significance level of 5% obtained that the value of 0.128 > 0.05 which has the same or homogeneous variance. Thus, it means that the sample comes from the same variance and conditions.

Based on the calculation of student learning outcomes in the experimental and control classes, the results of the quantitative analysis can be summarized in Table 2.

Table 2. Results of Quantitative Analysis

Test	t_{value} or z_{value}	t_{table} or z_{table}	Interpretation
Average test	9.849	1.68	H_1 accepted
Classical completeness test	2.66	0.3264	H_1 accepted
Average different test	3.309	1.67	H_1 accepted

Results of the post-test data obtained from the score of problem-solving ability in the two classes used in the study are presented in Table 3.

Based on the results of the analysis of the test data of the problem-solving ability in the experimental class, it was found that Problem-Based Learning (PBL) learning based on ethnomathematics had achieved completeness. The percentage of students who exceeded the KKM in the learning Problem-Based Learning (PBL) based on ethnomathematics reached 94%. This results indicated that the implementation of the Problem-Based Learning (PBL) learning model based on ethnomathematics is effective

towards students' problem-solving abilities. The results of the test data analysis of the problem-solving ability in the control class found that Problem-Based Learning (PBL) learning model has not yet reached its completeness. This result indicated that the implementation of the Problem-Based Learning (PBL) learning model has not been effective on students' problem-solving abilities.

Table 3. Results of Test of Problem Solving Ability

Class	N	Mean	Maximum	Minimum	Complete	Incomplete	Proportion (%)
Experiment	37	86	100	71	35	2	94
Control	37	80	100	66	26	11	70

After the two classes were given a different treatment, then to find out whether the Problem-Based Learning (PBL) model based on ethnomathematics is effective on the ability of problem-solving. Then, the final test was given as an evaluation of problem-solving abilities.

After obtaining a different learning that is using Problem-Based Learning (PBL) model based on ethnomathematics for the experimental class, and the learning using the Problem-Based Learning (PBL) model for the control class, it can be seen that the average test results of the problem-solving abilities of the experimental class students was 86, and the control class was 80.

The average test results using SPSS 22 with one-sample t-test in the t-test obtained t_{value} = 9.849 and t_{table} = 1.68. Since $t\_{value} > t_{table}$, H_0 is rejected. Therefore, it can be concluded that the average problem-solving ability in classes using Problem-Based Learning (PBL) models based on ethnomathematics is more than the KKM score of 75. From the classical completeness test results obtained $z_{value} = 2.66 \geq z_{(0.5-\alpha)} = 0.3264$, which means that the proportion of students' problem-solving abilities using Problem-Based Learning (PBL) model based on ethnomathematics has reached the classical completeness of 75%.

The average difference test results of students' problem-solving abilities in the post-test group can be shown in Table 4.

Table 4. Result of the Post-test Group

Class	N	Mean	Std. deviation	Std. error mean
Experiment	37	85.8378	6.69375	1.10045
Control	37	80.3514	7.54327	1.24011

The results of the average difference test of students' problem-solving abilities can be seen in the following in Table 5 of independent sample t-test.

Table 5. Results of Independent Sample t-test

	Levene's test for equality of variances		t-test for equality of means						
	F	Sig.	t	df	Sig.	Mean difference	Std. error deviation	95% Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	.456	.502	3.309	72	.001	5.48649	1.65796	2.18140	8.79158
Equal variances not assumed			3.309	70.996	.001	5.48649	1.65796	2.18060	8.79238

Based on the average difference test using SPSS 22 with independent sample t-test using t-test obtained t_{value} = 3.309 and t_{table} using dk = $n_1 + n_{2-2}$ = 37 + 37-2 = 72 which is 1.67. Since $t_{value} > t_{table}$, H_0 is rejected. Therefore, it can be interpreted that the average problem-solving ability of students in the Problem-Based Learning (PBL) learning model based on ethnomathematics is better than the average problem-solving ability of students in the Problem-Based Learning (PBL) learning model without the ethnomathematics.

The results of the problem-solving abilities of students in the experimental class that given the Problem-Based Learning (PBL) model based on ethnomathematics is better than the results of the problem-solving ability of students in the control class which was not given the Problem-Based Learning (PBL) model based on ethnomathematics.

This result happened since, in the experimental learning, students were more active in the learning to find out formulas, understand formulas to be used in solving problems, discuss in solving problems, and explain the results of discussions in front of the class.

The learning process in the experimental class using the Problem-Based Learning (PBL) model based on ethnomathematics was able to create an interesting learning atmosphere with a cultural mix as a source of learning by the teacher in delivering the material to increase the activity of the students. The student activeness can be seen from the number of students who actively ask about the material of circumstances and wide of flat area or geometry, group discussions that was well conducted, and the seriousness of students in doing assignments given by the teacher.

During the learning process, students were able to actively discuss in groups to solve problems related to culture. In the experimental class, students' learning activities were more fun, full of enthusiasm, and high motivation to learn, as well as active students who make students more interested in the learning of mathematics so that the problem-solving ability in the experimental class is higher than in the control class students.

Meanwhile, the control class was given learning by using the PBL model. In the learning by using the PBL model, students exchanged information with their group friends to solve problems and obtained guidance from the teacher to solve problems. However, the group work done in the control class is still not effective. There were only a few active and prominent students in each group discussion. This makes all the problems given by the teacher was resolved privately without discussing it with the group. Thus, resulting in students absorbing less knowledge gained, resulting in lower problem-solving ability test results in the control class compared to the experimental class students.

Based on the results of the pre-test data analysis of the experimental class and the control class, it was found that the results of the experimental class tests on students who were taught using Problem-Based Learning (PBL) learning model based on ethnomathematics was better than the control class students who were taught using Problem-Based Learning (PBL) model without ethnomathematics. It was happened due to several things such as students in the learning using Problem-Based Learning (PBL) based on ethnomatematics obtained more student worksheet (LKPD) questions and problems as well as teaching materials about the circumference and shape of flat area or geometry (square, rectangular, and triangular) associated with the local culture in Salatiga, namely selotigo batik clothing, students in the learning using Problem-Based Learning (PBL) based on ethnomatematics were more active in asking about material that is not yet understood, such as the material of circumstances and width of flat area or geometry (square, rectangular, and triangular) presented with local culture of selotigo batik clothing both to a friends in a group or the teacher than the class with the model of Problem-Based Learning (PBL) without ethnomatematics, students in the learning using Problem-Based Learning (PBL) model based on ethnomatematics were more active in discussions than students in the Problem-Based Learning (PBL) model without the ethnomatematics so that students were able to understand the mathematical concepts of circumferences and width of flat area (square, rectangular, and triangular) which were directly related to the selotigo batik clothing in Salatiga.

The results of this study are in line with the results of the research of Heryan, Muwahiddah (2018) and Irawan (2017) who said that mathematics learning based on ethnomathematics could make active students in the teaching and learning process in mathematics and increase student motivation.

Barata, Zaenuri, and Sukestiyarno (2019) stated that learning based on ethnomathematics was better than conventional learning. The average score of classroom mathematical abilities that use ethnomathematics based learning is better than the classes that use learning by applying conventional learning (Kaselin, Sukestiyarno, & Waluyo, 2013).

The local culture in Salatiga which was used during the process of the implementation of the PBL learning with ethnomathematics nuances was the form of *Selotigo* batik motifs in Salatiga, Central Java, which are presented in Figure 1.

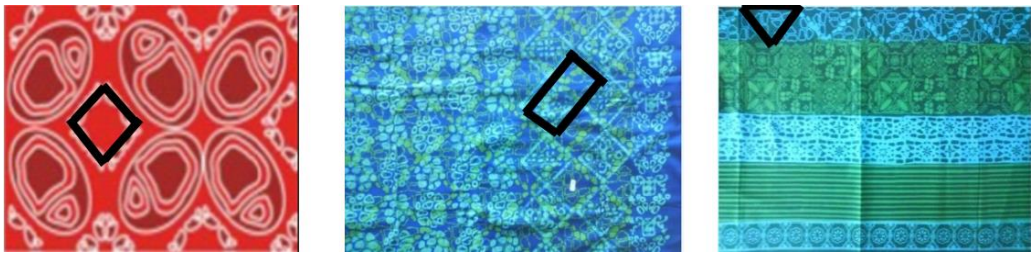

Figure 1. The motif of Batik Plumpungan, Motif of Batik Waturumpuk, Motif of Batik Waturumpuk

Figure 1 is *Plumpungan* batik motifs, and Waturumpuk batik motifs, the thick lines above show batik motifs with square, rectangular, and triangular patterns.

From the above figures, therefore, local culture especially *Selotigo* batik clothing is not only for consumption, but can also be used as a source of learning mathematics to broader explore students' knowledge and give more meaningful learning.

CONCLUSION

Based on the results of research on Problem-Based Learning (PBL) model based on ethnomathematics towards the problem solving ability of mathematics learning on the circumferential and flat area or geometry material, it can be concluded that Problem Based Learning (PBL) model based on ethnomathematics can be effectively used in the learning of mathematics, particularly geometry material. This result is due to several things such as the average score of students' problem solving abilities in the learning using the Problem Based Learning (PBL) model based on ethnomathematics exceeds the Minimum Completeness Criteria (KKM) with KKM problem solving abilities of 75, the proportion of completeness of problem solving abilities students with a Problem Based Learning (PBL) model based on ethnomathematics above the classical completeness of 75%, the average problem-solving ability of students in the learning model of Problem-Based Learning (PBL) based on ethnomathematics is better than the average ability of students' problem-solving in the Problem-Based Learning (PBL) model without the ethnomathematics.

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